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1999-2000 School Year

Chemistry 30 Information Bulletin

Diploma Examinations Program

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Purpose of the Bulletin

The purpose of these bulletins is to provide students and teachers with information about the diploma examinations scheduled for the 1999–2000 school year.

Please share the contents of these bulletins, particularly the sample questions, writing assignments, and the scoring criteria, with your students.

These bulletins include

- descriptions of diploma examinations that will be administered in November 1999, and in January, April, June, and August of 2000
- the blueprints for the examinations
- the scoring criteria for the 1999–2000 school year
- suggestions for students about writing the examinations
- descriptions of the standards for the courses and examinations
- examples of students' responses for Mathematics 30, Mathematics 33, Science 30, Biology 30, Chemistry 30, Physics 30. (Examples of students' responses for humanities examinations are on the extranet.)

Information for Markers/Teachers

Scoring and Marking of the Examinations

Scoring and marking of the examinations takes place shortly after each administration date.

All writing assignments and extended-response assignments are scored by teachers selected from among those who have been recommended as markers by their superintendents to the Student Evaluation Branch.

In early September, the Student Evaluation Branch sends superintendents a letter requesting the names of recommended markers. Dates for scoring the examinations are announced in this letter.

Student Evaluation Branch staff contacts recommended markers before each marking session to confirm their participation, as well as the dates and times for marking.

Qualifications

To qualify for recommendation by a superintendent, a teacher must have taught the diploma examination course for two or more years, be teaching the course in the current school year, hold an Alberta Permanent Professional Teaching Certificate and be employed by a school authority in Alberta.

Dates for Recommendation

Teachers who wish to be recommended as markers for the January or June diploma examinations should contact their superintendent by the dates given below. A teacher should clearly indicate to the superintendent which examination he or she wishes to mark.

Administration	**Contact Superintendent by**
January, 2000	October 1, 1999
June and August, 2000	March 1, 2000

Markers for the November examinations will be selected from the list submitted by superintendents for the previous June marking session; markers for the April examinations will be selected from the list for the previous January marking session.

Criteria for Selection

In most subjects, more teachers are recommended as markers by superintendents than are required by the Student Evaluation Branch for any one marking session. The following criteria are used when markers are selected for a particular marking session:

- experience as a marker (in some subjects, qualified first-time markers will be selected first; all selection will be done to balance numbers of new and experienced markers.)
- regional representation
- proportional representation by student population

Please note: teachers may mark only one subject in a marking session. No teacher may mark both a diploma examination and an achievement test in July.

Examination Development

As the need arises for teachers to participate in item writing and field testing, letters are sent to superintendents requesting their nominations. Item writing takes place throughout the year and is a vital component of the diploma examination program. Field testing provides important validation of questions. It also provides students and teachers with the opportunity to become familiar with the nature of questions they will encounter on future diploma examinations. Only teachers who have been nominated by their superintendents are eligible to participate in these activities. Teachers who are interested in these activities should contact their superintendents.

Inservices and Presentations

If you are seeking information about or wish to book a workshop related to diploma examinations, interpretation of examination results, and other examination-related issues, contact your Professional Development Consortia. You may also contact either Elana Scraba, Assistant Director Humanities, or Corinne McCabe, Assistant Director Mathematics/Science, at the Student Evaluation Branch at 780-427-0010 for information and to book speakers.

Other Important Documents

Student Evaluation produces many important documents that people who are seeking information about diploma examinations will find helpful. All of these documents are posted either on the Alberta Learning site (http://ednet. edc.gov.ab.ca) or on the secured Alberta Learning extranet.

- *Students First: A Guide for Students Preparing to Write a Diploma Examination*—A *Students First* guide is produced for each diploma examination subject. These publications contain valuable information and suggestions for students about examination preparation and examination writing. We recommend that students and teachers examine these documents early in the term to prepare for the diploma examinations

- *General Information Bulletin, Diploma Examinations Program (1999–2000)*—Each September, the Student Evaluation Branch sends all superintendents and senior high school principals copies of the *General Information Bulletin, Diploma Examinations Program.* This bulletin provides the information, dates, policies, and rules that apply to the administration of all diploma examinations for the school year. It also provides information about partial writings, the use of word processors, the use of calculators, accommodations for students with learning and/or physical disabilities, dates for examination administration, and definitions of mature students, among other things.

- *Examples of Students' Writing*—Samples of student writing from the January 1999 examination administration of English 30, English 33, Social Studies 33,and Social Studies 30 are posted on the Alberta Learning extranet. These examples represent the standards set for the marking of the examination. Teachers are able to access this secured web site through their school's identification number.

- *Examiners' Report*—Following the administration of January and June diploma examinations, the Student Evaluation Branch produces an *Examiners' Report* for each diploma examination. These documents are sent to all senior high schools in Alberta, and are posted on Alberta Education's extranet site.

  Each *Examiner's Report* contains
  - detailed provincial results
  - examiners' comments about student performance on the examination
  - a blueprint of the examination by reporting category
  - the key and difficult level for all questions on the examinations
  - sample questions accompanied by commentary

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Each *Examiners' Report* provides important information for teachers who wish to interpret their students' results in relationship to provincial results as an ongoing form of program evaluation.

- *School and Jurisdiction Reports*—These reports are made available electronically on the extranet to schools and school jurisdictions after each January and June administration. The *School and Jurisdiction Reports* provide detailed information on how well students in the school and school district, respectively, did on each of the diploma examinations relative to provincial standards. Teachers may use these data to reflect on areas of the program where their students did well and on areas where student performance could be improved.
- *Annual Report, Diploma Examinations Program*—This report contains information about the results achieved by all students who wrote diploma examinations in the preceding school year. It also contains the results of any special study related to the diploma examinations.

Diploma Examinations Program

Year	Special Studies Topic
1989–90	Comparing Achievement in Various Diploma Examination Courses
1990–91	Different Paths to Success in Diploma Examination Courses
1991–92	Participation Rates in Diploma Examinations Courses
1992–93	Conventions of Language
1993–94	Participation Rates Over Time
1994–95	Grade 12 Enrollment Decline—A Preliminary Assessment
1995–96	Differential Item Performance Between Males and Females on the June 1996 Administration of the Social Studies 30 Diploma Examination
1996–97	Achievement-Over-Time for English 30 and Social Studies 30 Diploma Examinations
1997–98	Special Study: Achievement-Over-Time for the Multiple-Choice Section of the English 30 and Social Studies 30 Examinations, 1989–1998
1997–98	Special Study: Achievement-Over-Time for the Biology 30 Extended Written-Response Question (June 1995 and June 1998 Comparison)

The 1996–97 and 1997–98 annual reports are available on the Internet at the Alberta Learning web site.

- *Previous Examinations:* Copies of previous Mathematics 30, Mathematics 33, Science 30, Physics 30, Chemistry 30, and Biology 30 diplomas examinations and keys are posted on the Alberta Learning web site. English 30, English 33, Social Studies 30, Social Studies 33, and Français 30 examinations are not available on the web site because of copyright restrictions for electronic publication of the source materials on these examinations. However, keys for the multiple-choice parts of all humanities examinations are posted.

  You may purchase copies of the diploma examinations from the Learning Resource Distributing Centre (LRDC)

  by phone: (780) 427-5775 (toll-free 310-0000)
  by fax: (780) 422-9750
  on the web: www.lrdc.edc.gov.ab.ca
  by mail: 12360-142 Street, Edmonton, AB T5L 4X9

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General Scoring Guides for Open-Response Question

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Objectives of the Course

Chemistry 30 is intended for students who want to better understand the chemistry principles behind the natural events they experience and the technology they use in their daily lives. Chemistry 30 is an experimental discipline requiring creativity and imagination. It develops the knowledge, skills, and attitudes to help students become capable of and committed to setting goals, making informed choices, and acting in ways that will improve their own lives and life in their communities.

Students of Chemistry 30 have developed their aptitude for observing, collecting facts, forming generalizations, hypothesizing, and making inferences from observations. They have shown growth in their understanding of chemical concepts, ability to apply these concepts to relevant situations, and ability to communicate in the specialized language of chemistry.

This growth and development in students has taken place as a result of general education and cognitive maturation. It has been enhanced by science courses, and in particular by the successful completion of Science 10 and Chemistry 20. These courses and concurrent mathematics courses develop knowledge and skills that are prerequiste to success in Chemistry 30.

Standards

Acceptable Standard

Students who attain the *acceptable standard* but not the *standard of excellence* in Chemistry 30 will receive a final course mark between and including 50% and 79%. These students can demonstrate a basic understanding of the nature of scientific investigation by designing, observing, and interpreting simple laboratory tests. They can readily interpret data that are presented in simple graphs and tables, and can translate symbolic representations into word descriptions. They can readily recognize and provide definitions for key chemical terms. They can predict the physical and chemical properties of compounds. These students can demonstrate an understanding of chemical concepts by performing routine stoichiometric problems that involve single steps. They are capable of balancing an equation (combustion, formation, neutralization, or oxidation-reduction) and solving standard stoichiometric problems based upon these equations. Following the directions in laboratory procedures does not present a problem for these students, nor does using the data booklet to extract valid information. These students can compose clear and logical descriptive or explanatory statements to answer closed-response questions that involve an individual chemistry concept.

Standard of Excellence

Students who achieve the *standard of excellence* in Chemistry 30 receive a final mark of 80% or higher. In addition to meeting the expectations for the *acceptable standard* of performance, these students demonstrate an interest in chemistry and can articulate chemistry concepts well. They can readily interpret interrelated sets of data such as complex graphs and tables. When presenting scientific data, they select the most appropriate form. These students can analyze and evaluate experimental designs. They can create their own laboratory procedures when given a clear definition of a problem. They can recognize weaknesses in laboratory work and can find ways to correct the weaknesses. They can write their own equations for formation, combustion, neutralization, redox reactions, and equilibrium expressions, and can solve many variations of stoichiometric problems based upon these equations. They are able to transfer what they see happening in a test tube into equation form and are able to express scientific ideas clearly. They can usually cope with problems that involve overlapping of two or more concepts. The most significant characteristic of this group is that they can solve problems of a new and unique nature and can extrapolate these solutions to higher levels of understanding. Open-ended questions are not a problem for them. These students can communicate clearly and concisely, using appropriate scientific vocabulary.

Achievement Standards

At a provincial level it is expected that at least 85% of students will achieve a final course mark of 50% or higher. It is also expected that at a provincial level, at least 15% of students will achieve a final course mark of 85% or higher.

Examination Specifications

Each Chemistry 30 diploma examination is designed to reflect the Chemistry 30 course general learner expectations outlined in the *Chemistry 20–30 Program of Studies, Interim 1995, for Senior High Schools*. Each examination is built as closely as possible to these specifications. Small adjustments in emphasis may be necessary because the examination includes multimark written-response questions and/or machine-scored questions that cover more than one concept area. The concept areas are distributed proportionately over the examination. Questions that require knowledge and skill in applying scientific processes are distributed throughout the examination but are not associated directly with specific topics; this is also true of the STS connections.

The 1999–2000 Chemistry 30 diploma examinations are constructed to place the following approximate emphases on the Chemistry 30 course general learner expectations (GLE).

		Emphasis (Curricular Fit)
GLE 1	Quantitatively Predicting Outcomes	30–40% (Unit 1, 2, 3)
GLE 2	Qualitatively Analyzing Systems	60–70% (Unit 1, 2, 3)
GLE 3	Relationships in Energy Transfer	28–32% (Unit 1)
GLE 4	Relationships in Electron Transfer	30–34% (Unit 2)
GLE 5	Relationships in Equilibrium Systems	16–22% (Unit 3)
GLE 6	Relationships in Proton Transfer	16–22% (Unit 3)

Knowledge	***Emphasis***
The student can:	100%
• apply conservation of matter and energy to changing systems; use evidence and knowledge to predict outcomes in a broad range of reactions	30%–40%
• analyze and evaluate physical, chemical, and biological systems in terms of energy, matter forms, transfers, movement, and conservation	60%–70%
• explain the relationships in physical, chemical, and nuclear changes through the rearrangement of bonds and the resulting release or absorption of energy	28%–32%
• quantitatively and qualitatively explain and analyze the transfer of electrons and the associated transformations that take place in electrochemical systems	30%–34%
• quantitatively and qualitatively describe equilibrium systems for acids, bases, and gases and some of their applications	16%–22%
• quantitatively and qualitatively describe acids and bases in physical and conceptual terms using the Brønsted–Lowry theory	16%–22%

Scientific Process and Communication Skills (SPC) ***Emphasis***

40–60%

The student can:

- design, interpret, explain, analyze, and evaluate investigations
- organize data into tables, graphs, and diagrams and predict relationships
- interpret, explain, analyze, and evaluate data to infer relationships
- use appropriate scientific terminology and mathematical language to communicate and explain scientific concepts

Science, Technology, and Society Connection (STS) ***Emphasis***

40–60%

The student can:

- apply cause-and-effect reasoning to formulate relationships in which scientific evidence shapes or refutes a theory, and explain the limitations of science and technology in answering questions and solving problems
- describe and evaluate the design and function of technological solutions to theoretical and practical problems, and relate the ways in which science and technology advance one another
- evaluate from a variety of perspectives how science and technology are influenced and supported by society; assess the ability of society to interact responsibly with the environment
- apply the skills and knowledge acquired in science to everyday life

Examination Design

The design of the 1999–2000 Chemistry 30 diploma examinations is as follows:

Question Format	*Number of Questions*	*Percent Emphasis*
Multiple Choice	44	55
Numerical Response	12	15
Written Response	2	30

The machine-scored portion of each examination contains both multiple-choice and numerical-response questions, some of which may be linked together.

Some examination questions are organized into sets that relate to broad contexts. Therefore, a set of questions may assess students' ability to integrate several general learner expectations (GLEs). All questions will measure achievement of scientific knowledge; some will also measure achievement of scientific process and communication skills and/or STS connections.

Answers for multiple-choice questions are recorded in the first section of the machine-scored answer sheet, and answers for numerical-response questions are recorded in the second section on the same side of the same machine-scored answer sheet. Answers to the written-response questions are written directly in the exam booklet.

Multiple-choice questions are of two types: *discrete* and *context dependent*. A discrete question stands on its own without any additional directions or information. It may take the form of a question or an incomplete statement. A context-dependent question provides information separate from the question stem. Many of the multiple-choice questions are *context dependent*. A particular context may be used for more than one multiple-choice question as well as for one or more numerical-response questions.

Numerical-response questions are of three types: calculation of numerical values, selection of numbered events or structures from a diagram/list, and determination of a sequence of events.

The **written-response** portion of each Chemistry 30 Diploma Examination contains two questions: a closed-response question that is analytically scored and an open-response question that is holistically scored. Each question has a value of 15% of the examination.

Linked questions are included in the machine-scored portion of the examination. The correct answer for any machine-scored question will always be scored as correct. For linked questions, an answer from one question may be necessary to complete the next question. If students answer the first question incorrectly but use that answer correctly to answer the second question, they will receive full marks for the second question.

To illustrate by example, multiple-choice question 22 and numerical-response questions 4 and 5 on the January 1999 Chemistry 30 Diploma Examination are of this type.

Use the following information to answer the next three questions.

> A student dipped 12.50 g strips of four different metals, $Ag_{(s)}$, $Cu_{(s)}$, $Pb_{(s)}$, and $Mg_{(s)}$, into a beaker containing 250 mL of 1.00 mol/L $HCl_{(aq)}$ in order to determine an activity series. One of the metals reacted immediately and vigorously with the acid.

22. The balanced net-ionic equation for the first reaction that occurred is

A. $2Ag_{(s)} + 2H^{+}_{(aq)} \rightarrow H_{2(g)} + 2Ag^{+}_{(aq)}$
B. $Cu_{(s)} + 2H^{+}_{(aq)} \rightarrow H_{2(g)} + Cu^{2+}_{(aq)}$
C. $Pb_{(s)} + 2H^{+}_{(aq)} \rightarrow H_{2(g)} + Pb^{2+}_{(aq)}$
•D. $Mg_{(s)} + 2H^{+}_{(aq)} \rightarrow H_{2(g)} + Mg^{2+}_{(aq)}$

Use the answer selected for ***Multiple Choice 22*** *to answer* ***Numerical Response 4.****

Acceptable Linked Question Responses

If MC22 is A, then NR4 is 0.80
B, then NR4 is 0.34
C, then NR4 is 0.13
•D, then NR4 is 2.37

Numerical Response

4. The electrical potential for this reaction is +/– __________ V.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

***You can receive marks for this question even if the previous question was answered incorrectly.**

Use the answer selected for ***Multiple Choice 22*** *to answer* ***Numerical Response 5.****

If MC22 is A, then NR5 is 12.5
B, then NR5 is 7.94
C, then NR5 is 12.5
•D, then NR5 is 3.04

Numerical Response

5. The mass of metal that reacted with the hydrochloric acid is __________ g.

(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

***You can receive marks for this question even if Multiple Choice 22 was answered incorrectly.**

Assessment of STS Connections

Chemistry 30 examination questions are intended to measure the students' understanding of concepts. Some questions also measure students' understanding and use of skills associated with scientific inquiry, and some questions have been designed to measure students' understanding of the connections between science and technology and among science, technology, and society. As a result, many questions measure how well students can apply the skills and knowledge they have acquired in science to everyday life.

Industries, businesses, and post-secondary institutions in Alberta have been helpful in providing real-life contexts for STS questions, as well as in making connections between real life and the curriculum. The development of test items, from the writing stage until they appear on an examination, may take a number of years. The contributions of the following institutions have enhanced the quality of the diploma examination program in Alberta.

API Grain Processors, Red Deer
Banff Wastewater Treatment Plant, Banff
Bonnybrook Water Treatment, Calgary
Bow Valley Brewing Company, Canmore
Concordia University College of Alberta
Kawneer Canada Ltd., Lethbridge
Lethbridge Iron Works, Lethbridge
Prairie Chemical Inc., Edmonton
Syncrude, Fort McMurray
Texas Instruments
University of Alberta
University of Lethbridge
Wascana Energy, Balzac

Assessment of Communication Skills

Communication skills are assessed most directly in the marker-scored questions. For the open-response question, the descriptions used in the scoring guides include criteria for assessing communication skills along with criteria for assessing science content. Examples of scoring criteria from January 1998 Diploma Examination can be found in the *Archived Information* from previous bulletins.

The term *communication skills* includes those processes by which understandings are expressed using appropriate English and scientific conventions. These conventions include:

- graphs and diagrams
- mathematical formulas and equations
- significant digits, units of measurement, and unit conversion
- states of matter
- abbreviations
- sentence construction, grammar, and mechanics

Conventions that are considered appropriate for a particular response are subject- and question-specific.

Reminders and Explanations

Data Booklet Access

NEW

Alberta Learning continues to receive a number of requests for Chemistry 30 Data Booklets. These booklets are only available from the LRDC (Learning Resources Distributing Centre) at 12360 - 142 St. in Edmonton. The cost is less than fifty cents per copy.

Revised French Data Booklets

NEW

Because of the number of errors in the 1995 version of the French Chemistry 30 Data Booklet, a new version will be available in September 1999. This 1999 version will be the standard used for diploma examinations starting with the November 1999 administration.

Schools that traditionally offer Chemistry 30 in French should receive a copy of the revised data booklet early in the 1999–2000 school year.

Perspectives in STS Decision Making

NEW

Decision making is an important component of the senior high school science programs and is supported by general and specific learner expectations for attitudes, skills, and the science, technology and society connections identified in the 1995 *Interim Program of Studies*.

The related general outcome for attitudes states: "Students will be encouraged to develop open-mindedness and *respect for the points of view of others*." (Page 3)

The related general outcome for skills states: "Students will be expected to develop an ability to use thinking processes associated with the practice of science for understanding and exploring natural phenomena, problem solving and decision making," and, when "evaluating the process or outcomes," students are to "consider consequences and biases, assumptions, and *perspectives*." (Page 5)

The related general outcome for STS connections states: "Students will be expected to explain and evaluate for a given instance, and *from a variety of given perspectives* how science and technology are influenced and supported by society; and assess the ability and responsibility of society, through science and technology, to protect the environment and use natural resources wisely." (Page 7)

Societal decision making is informed by many other interest areas, for example, science, technology, politics, and ethics, which are generally referred to as perspectives. Specific outcomes in the program of studies, such as those requiring students to assess the risks and benefits of a societal decision, provide opportunities for students to practice considering perspectives on issues related to science. The following list of perspectives, while not exhaustive, can provide guidance for teachers in their instruction and assessment of students. STS perspective questions can be asked in any of the three Chemistry 30 units.

Perspective	**This perspective relates to:**
Scientific	the current knowledge, research, concepts, or theories of science
Technological	the processes and products that result from the human desire to change the world to better serve our needs
Ecological/ Environmental	the balance in the biosphere of the relationships among living systems and of living systems with their environment
Economic	the production and distribution of wealth
Political	the policies, laws, and programs of government
Legal	the laws of a jurisdiction
Societal	the community, its culture, and human relations
Ethical	considerations of what is right or wrong

Sample Perspective Question

7. "The use of fossil fuels as an industrial energy source contributes to global warming." This statement is made from a perspective that is primarily

A. scientific
B. political
C. economic
•**D.** ecological

Exemplar Field Test Items

The following questions have been selected from the 1998–99 field tests to illustrate some common student misconceptions.

Phosgene, $COCl_{2(g)}$, was one of the chemical weapons used in combat during the First World War. It can be produced by chlorinating carbon monoxide, as represented by the equation

$$CO_{(g)} + CL_{2(g)} \rightleftharpoons COCl_{2(g)} \qquad \Delta H = -109\ \text{kJ}$$

Students are required to calculate the enthalpy change for a reaction or the heat of formation of a reaction species using Hess's Law. The most common answer for this numerical-response question was 1.09.

Students made the assumption that the reaction provided was a simple formation reaction. Students who answered 1.10 or 1.11 appear to have confused carbon monoxide with phosgene.

Numerical Response

7. The heat of formation of $COCl_{2(g)}$ is –__________ × 10^2 kJ/mol.
(Record your **three-digit answer** in the numerical-response section on the answer sheet.)

Answer: 2.20

Use the following information to answer the next question.

$$\underset{\substack{\text{green}\\ \text{solution}}}{\_MnO_4{}^{2-}{}_{(aq)}} + \_H_2O_{(l)} \rightleftharpoons \underset{\substack{\text{purple}\\ \text{solution}}}{\_MnO_4{}^{-}{}_{(aq)}} + \underset{\substack{\text{brown}\\ \text{precipitate}}}{\_MnO_{2(s)}} + \_OH^{-}{}_{(aq)}$$

Students are expected to balance oxidation-reduction reactions using a variety of methods: inspection, use of half-reaction tables, changes in oxidation states/number. The most common answer, 2114, indicates that these students used inspection to balance the atoms but failed to balance the equation electronically. Charge conservation is a fundamental feature of redox reaction balancing methodology.

Numerical Response

2. When the equation above is balanced using lowest whole numbers, the coefficient of

$MnO_4{}^{2-}{}_{(aq)}$ is	__________	(Record in the **first** column)
$MnO_4{}^{-}{}_{(aq)}$ is	__________	(Record in the **second** column)
$MnO_{2(s)}$ is	__________	(Record in the **third** column)
$OH^{-}{}_{(aq)}$ is	__________	(Record in the **fourth** column)

(Record your answer in the numerical-response section on the answer sheet.)

Answer: 3214

Use the following information to answer the next question.

Acids found in a variety of common compounds include:

Acid	Common Name	pH	Acid Name	K_a
1	Vinegar	2.60	acetic acid	1.8×10^{-5}
2	Pop	3.40	carbonic acid	4.4×10^{-7}
3	Orange juice	3.50	citric acid	7.5×10^{-4}
4	Sour milk	3.80	lactic acid	1.4×10^{-4}

8. A solution of orange juice is diluted with water until the concentration of hydronium ions produced by the dissociation of the citric acid is 1.4×10^{-8} mol/L. The pH of the resulting solution is

A. 7.87
•B. 7.00
C. 6.13
D. 3.12

Students are expected to know that dilution cannot be used to convert an acid to a base or vice versa. Most students selected A because they calculated the pH without considering the $[H_3O^+_{(aq)}]$ from the dissociation of water.

Convention

During field-test marking, it was noted that a number of students record e^{-7} for 10^{-7} when providing written-response answers in scientific notation. This is **not** an appropriate scientific convention; thus, students could lose communication marks for this error.

When performing calculations, students are expected to use the values of the constants or referenced values provided in the data booklet and **not** the values programmed in a calculator.

- For written-response questions, significant digits will be considered for the final answer only. Units must be present throughout the entire written-response question to receive full communication marks.
- States of matter in equilibrium expressions should be applied consistently; either include all states or no states for full communication marks. E.g.

$$K_a = \frac{[H^+][A^-]}{[HA]} \quad \text{or} \quad K_a = \frac{[H^+{}_{(aq)}][A^-{}_{(aq)}]}{[HA_{(aq)}]}$$

- Students should have a working knowledge of involving the mega and kilo prefixes. Conversion for less commonly used prefixes will be provided.

Electrochemical Cells

Line or cell notation is used to describe electrochemical cells. On past diploma examinations, anode and cathode substances were indiscriminately placed on either side of the double vertical lines that designate the porous boundary separating two half-cells. The convention that will be used on future diplomas will be as follows: the substance constituting the anode is listed at the far left and the substance constituting the cathode is listed at the far right.

Standard state conditions and corresponding $E°$ values imply the use of 1.0 mol/L reagents. The larger the concentration of the reactants, the larger the E value. The Nernst equation would be required to calculate E values as a function of reactant and product concentrations in a redox reaction and is beyond the scope of the Chemistry 30 *Program of Studies*. However, students should know that as the reaction proceeds, the voltage generated will decrease as reactants are converted to products until reaching equilibrium at which point the battery “dies.” Cell potential is like an equilibrium, in that concentration changes provide the driving force for the reaction.

For half-cells containing acidified solutions (such as acidified potassium permanganate and an inert electrode), each half-cell should include **all** the active components in their standard state; that is, 1.0 mol/L $H^+_{(aq)}$, 1.0 mol/L $MnO_4{}^-_{(aq)}$, and 1.0 mol/L $Mn^{2+}_{(aq)}$. Together with an iron half-cell, the line notation is represented as

$$Fe_{(s)} / Fe^{2+}_{(aq)} // MnO_4{}^-_{(aq)}, Mn^{2+}_{(aq)}, H^+_{(aq)} / Pt_{(s)}$$

Archived Information from Previous Bulletins

NEW

Each bulletin contains unique information of value to teachers, especially teachers new to the program. Information such as course clarifications, reminders and explanations, and definitions of terms that are relevant to the diploma examination program can be found in the *Archived Information* section of specific subject bulletins on the web site. Only information that is applicable to current diploma examination programs has been archived.

Year	Topic
1998-99	• *Examination Design* - Sample linked question
	• *Reminders and Explanations in the 1999 Examinations* - Calculations related to titration data - Numerical-response digits - Field Test questions on buffers
	• *Written-Response Questions* - Sample open-response question, sample students' responses, and scoring rationales
1997-98	• *Emphases in the 1997-98 Examinations* - Fission versus fusion - Balancing of nuclear reactions - Components of kinetic energy - Rounding of linked-questions - Factors that affect an equilibrium and/or the equilibrium constant - Use of color charts in the data booklet
	• *Sample Test Items and Solutions*
1996-97	• *Emphases in the 1997 Examinations* - Calculations involving the Ideal Gas Law - Determination of equivalence-point - Use of the approximation rule to solve equilibrium expressions - K_b calculations
	• *Sample Test Items*

1995-96

- *Emphases in the 1996 Examinations*
  - Use of unfamiliar terms in context
  - Prediction of non-quantitative reactions
  - $K_a \times K_b = K_w$ calculations
  - Balancing of half-reactions in basic environments
  - Use of the quadratic equation
  - Use of the terms precision, readability, and accuracy
  - Percent reaction calculations
  - Definitions of hypothesis, conclusion, experiment, and variables

- *Sample Test Items*

- *One- and Two-Marker Scoring Systems*
  - Scoring of sample answers

1994-95
New
curriculum
implemented

- *Emphases in the 1995 Examinations*
  - Devising balanced half-reactions in acid or neutral solutions
  - Balancing auto-oxidation (disproportionation) reactions
  - Roundin gof numerical answers
  - Appropriate SI notation
  - Calculations using $\Delta E_p = vc\Delta t$
  - Oxidation number/oxidation state
  - Electrochemical cells as either voltaic or electrolytic cells
  - Use of amphiprotic/amphoteric
  - Use of equivalence point and endpoint

- *Conventions (Skill) Assessment of Written Response*
  - Use of shorthand
  - “Box” method
  - Appropriate terminology

- *Sample Test Items, Scoring Criteria, and Sample Answers*

Written-Response Questions

Each Chemistry 30 Diploma Examination has two written-response questions. One of these is a closed-response question. The score assigned addresses the level of understanding demonstrated by the response, the completeness of the response, and the degree to which the response communicates the student's understanding of the chemistry principles involved in solving the problem.

The other written-response question is an open-response question. Each student's answer to the open-response question is scored independently by two markers using holistic (open-response) scoring guides. The guides describe the characteristics of a student's answer that correspond to one of five values (0, 1, 2, 3, or 4) for the effective chemistry content used to solve the problem and one of five values (0, 1, 2, 3, or 4) for the communication of the response. The two content scores are added together for a combined total sub-score out of 8, while the two communication scores are averaged for a sub-score out of 4. The two sub-scores are added together for a total score out of 12.

A summary of the calculations follows:

Scale 1 (Chemistry Content): Marker 1 Score (X out of 4) + Marker 2 Score (Y out of 4) = Sub-score (X + Y out of 8)

Scale 2 (Communication): Marker 1 Score (X out of 4) + Marker 2 Score (Y out of 4) divided by 2 = Sub-score $\left(\frac{X+Y}{2} \text{ out of } 4\right)$

Final score = Content (out of 8) + Communication (out of 4) = maximum of 12 marks

If the scores for content obtained by the two independent markers vary by 2 or more, the scores are classified as *discrepant*. Responses that have *discrepant* scores are read by a third marker. The third marker must assign a score that is equal to one of the scores of the first two markers or that is between these scores.

A summary of the calculation for a discrepant paper follows.

Content: Marker 1 assigned a score of 1 out of 4 marks
Marker 2 assigned a score of 3 out of 4 marks
Marker 3 must assign a 1, 2, or 3. This score will be doubled for a total out of 8.

For an example of a scoring guide and open-response question from Chemistry 30 January 1998 diploma exam (Archived Information).

General Scoring Guides for Open-Response Questions

CONTENT

Score	Criteria
4	The response addresses **all** key components of the question and is fully and correctly supported.
3	The response addresses **all** key components of the question. There are more correct support arguments/procedures/algorithms than incorrect or unstated ones.
2	The response addresses **all** key components of the question. However, there are more incorrect or unstated support arguments/procedures/algorithms than correct ones. **OR** **Not all** key components are presented. Therefore, the response presented is valid but incomplete. Of all possible support arguments/procedures/algorithms, more are correct than incorrect or unstated.
1	The response presented is valid but incomplete and therefore cannot generate a complete response. Of all the possible arguments/procedures/algorithms presented, more are incorrect or unstated than are correct.
0	Overall, the response presented is inappropriate or incorrect for the problem.
NR	No response given.

COMMUNICATION

Score	Criteria
4	The response addresses **all** the key components of the question. No reference to the question is needed to understand the response. The marker does not have to interpret any part of the response. The response is clear, concise, and presented in a logical manner. The writing demonstrates confident control of correct sentence construction, grammar, and mechanics. There is a relative absence of errors given the complexity and completeness of the response. All appropriate scientific conventions are followed.
3	The response addresses **all** the key components of the question. No reference to the question is needed to understand the response. This writing demonstrates competent control of correct sentence construction, grammar, and mechanics. Minor errors in mechanics and grammar do not detract from the understanding. The marker may have to interpret the response or there may be one or more errors in scientific conventions.
2	The response address **all** the key components of the question. The marker has to interpret the response, or the response is so poorly organized that the marker has to refer to the question in order to understand the response. The writing may be ambiguous and/or disorganized, and there are errors in the scientific and/or language conventions used. **OR** The response **does not address all** the key components of the question. The marker does not have to interpret any part of the response. The writing demonstrates control of the basics of correct sentence structure, grammar, and mechanics, and there are no errors in the scientific conventions used.
1	The response is limited and **does not address all** the key components of the question. The marker may have to interpret the response, and there may be errors in the scientific conventions used. This writing demonstrates lack of control of correct sentence construction, grammar, and mechanics, which impedes communication. There may be one or more errors in the scientific conventions used.
0	This response **does not address all** the key components of the question and/or is totally inappropriate. The marker has to interpret the response, and there are errors in the conventions used.
NR	No response given.

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